

EXHIBIT A

Caroline Hoxby, Ph.D.

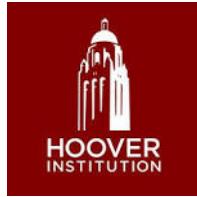
Direct Examination Demonstratives

SFFA v. UNC et al., Case No. 14-cv-954 (MDNC)

Caroline Hoxby, Ph.D.



Scott and Donya Bommer
Professor in Economics
Stanford University (2007 – Present)



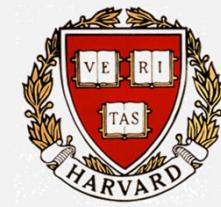
Program Director
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Previous Employment at Harvard University:
Harvard College Professor (2005-2007)
Allie S. Freed Professor of Economics (2001-2007)
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EDUCATION

Ph.D., Economics
Massachusetts Institute of Technology (May 1994)
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University of Oxford (June 1990)
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Questions Posed



Assess SFFA's allegations regarding UNC's admissions process, including the allegation that race and ethnicity is a dominant factor in the process.



Consider potential race-neutral alternatives to determine whether they can attain the levels of racial and ethnic diversity and academic preparedness achieved through UNC's current race-conscious admissions practice.



Respond to the opinions of Peter Arcidiacono and Richard Kahlenberg.

Opinions Reached

1

Empirical analysis establishes that UNC's admissions decisions are holistic and cannot be explained using a formula containing verifiable student characteristics.

Race / ethnicity is not a dominant factor in the admissions process at UNC.

2

Exhaustive simulations resulted in no race-neutral admissions policy that would allow UNC to attain the levels of academic preparedness and underrepresented minority representation of its actual entering class, even when those simulations are built on generous assumptions to maximize their chances of attaining the actual levels.

Opinions Reached

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UNC Admissions Regression Models

Row	Description of Specification [2]	R ²
(1)	SAT Combined, ACT Comp [3] [4]	0.121
(2)	(1) + SAT Subscores, ACT Subscores [3] [4] [5]	0.127
(3)	(1) + Class Rank, GPA	0.254
(4)	(3) + Sex	0.254
(5)	(4) + NC Resident	0.364
(6)	(5) + Min Coursework, HS Sport, Faculty / Staff Child	0.398
(7)	(6) + Alum Parent, Early Action	0.406
(8)	(7) + Parents' Education, Foreign Citizenship, Fee Waiver	0.409
(9)	(8) + Within-School GPA Rank (SGR)	0.428

DX 110.1 – Opening Report Ex 1, Table 1

R^2 versus Pseudo- R^2

Professor McFadden on the Pseudo R Square Metric

"Those unfamiliar with the p_2 index should be forewarned that its values tend to be considerably lower than those of the R^2 index and should not be judged by the standards for a 'good fit' in ordinary regression analysis. For example, values of 0.2 to 0.4 for p_2 represent an excellent fit."

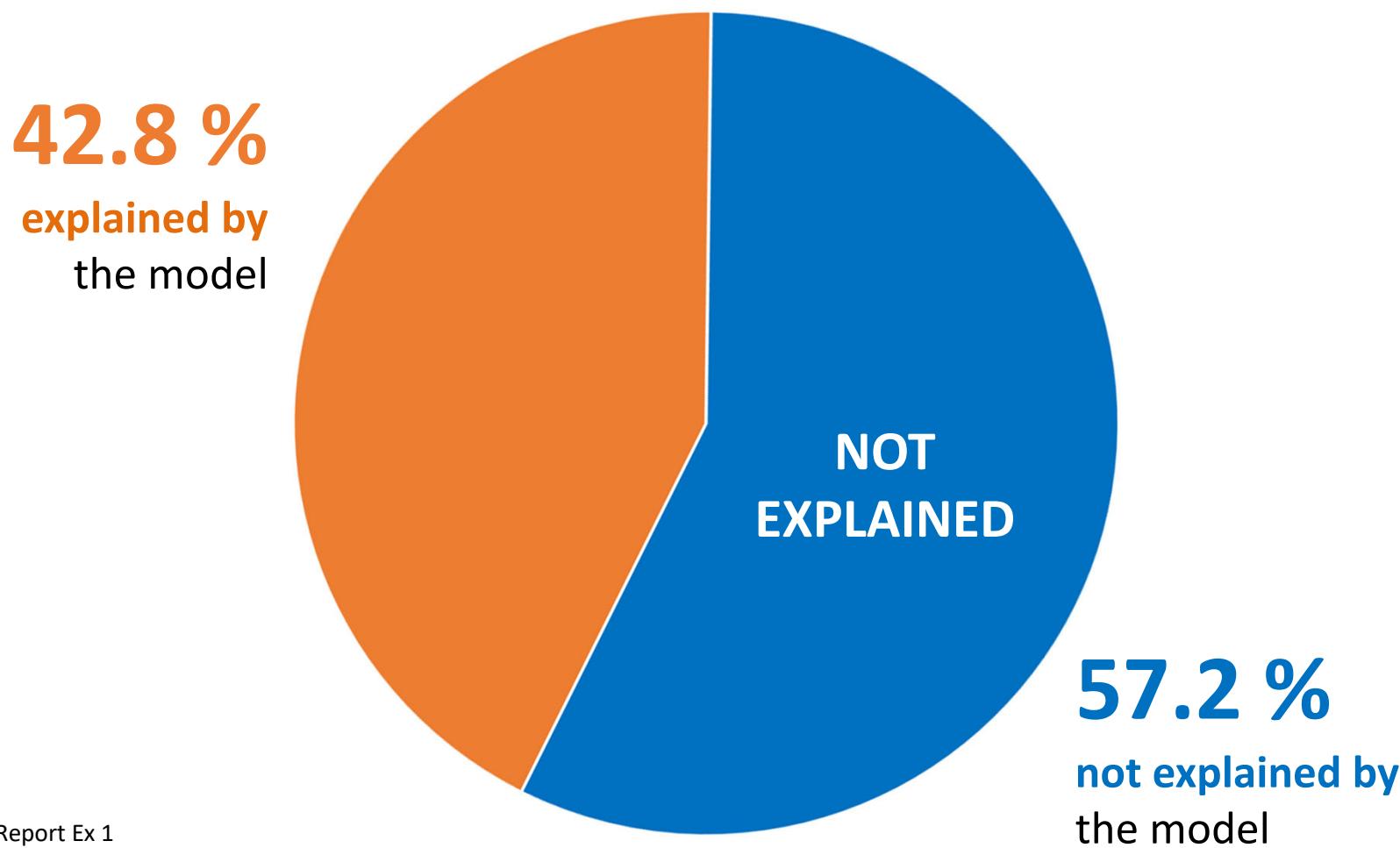
- D. McFadden, "Quantitative Methods for Analysing Travel Behavior: Some Recent Developments," (Chapter 13 in Behavioral Travel Modeling, D.A. Hensher and P.R. Stopher, editors, Croom Helm Ltd., 1979.)

Arcidiacono Slide 51

- Both R^2 and Pseudo- R^2 are indices on a scale from 0 to 100%. McFadden designed Pseudo- R^2 to be as analogous as possible to R^2 (linear models). Pseudo- R^2 is for non-linear models.
- Arcidiacono's reference to McFadden is misleading because, in the article, McFadden is considering a multinomial (more than two possible outcomes) model. The more choices available, the more difficult it is to model choices. We judge Pseudo- R^2 by more generous standards when there are more choices.
- UNC's admit/reject decision is a *binary* (yes/no) choice, not a choice among several alternatives, so Arcidiacono's critique is misplaced.

UNC's Admissions Process is Holistic

PROBABILITY OF OBSERVED ADMISSIONS DECISIONS



Source:
DX 110.1
Opening Report Ex 1
Table 1

Shapley Decomposition

Economists have devised an econometric method designed to answer questions just like the one presented in this case: how to assess the role of various factors in admissions decisions. The optimal econometric method is known as a “Shapley Decomposition.”

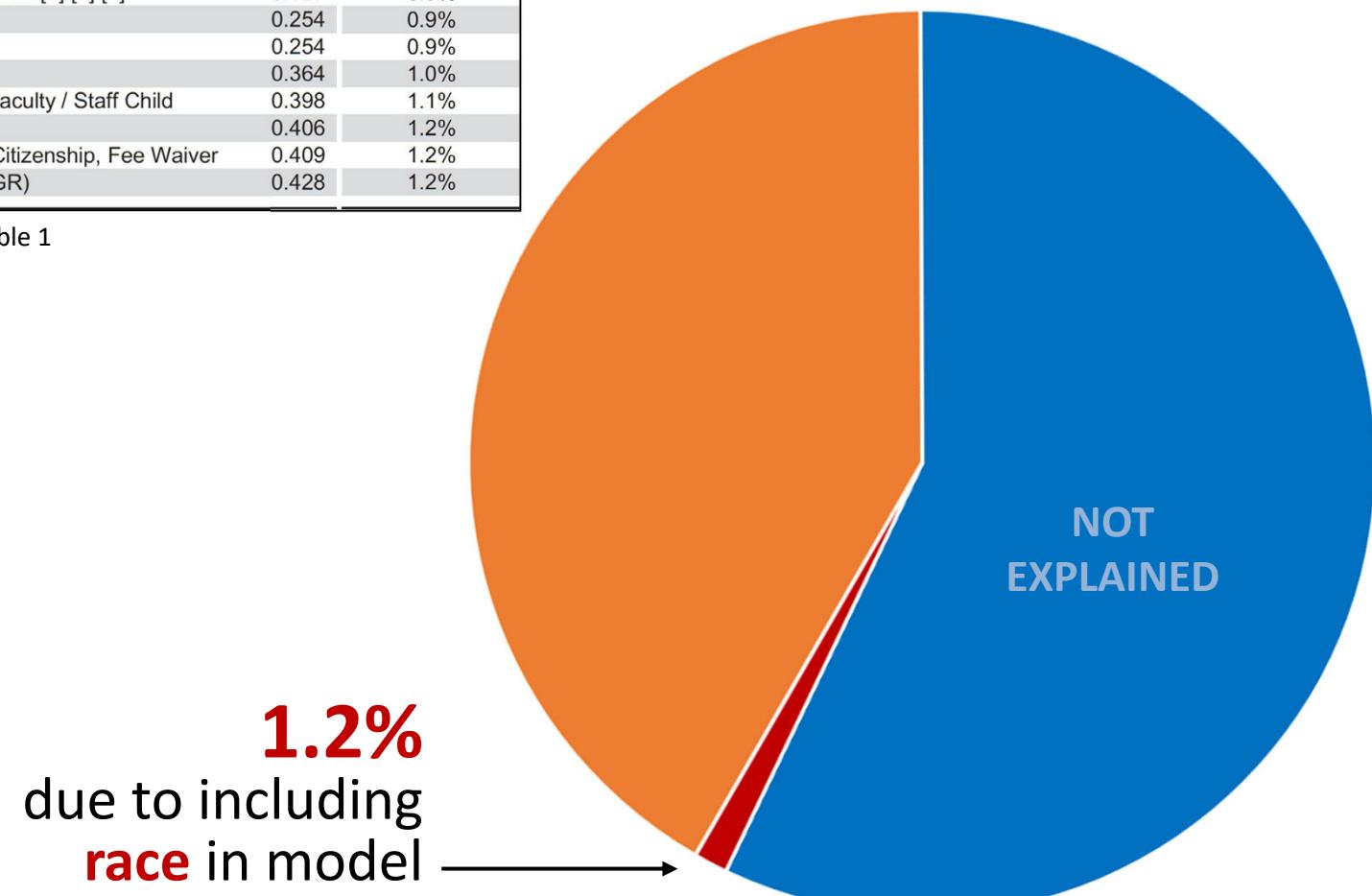
The Shapley Decomposition permits an economist to assess a model that has multiple factors where you seek to explain an outcome attributable to a factor or sub-group of factors.

The Contribution of Race to the Model

Row	Description of Specification [2]	R ²	Share of admission decision due to race/ethnicity
(1)	SAT Combined, ACT Comp [3] [4]	0.121	0.8%
(2)	(1) + SAT Subscores, ACT Subscores [3] [4] [5]	0.127	0.9%
(3)	(1) + Class Rank, GPA	0.254	0.9%
(4)	(3) + Sex	0.254	0.9%
(5)	(4) + NC Resident	0.364	1.0%
(6)	(5) + Min Coursework, HS Sport, Faculty / Staff Child	0.398	1.1%
(7)	(6) + Alum Parent, Early Action	0.406	1.2%
(8)	(7) + Parents' Education, Foreign Citizenship, Fee Waiver	0.409	1.2%
(9)	(8) + Within-School GPA Rank (SGR)	0.428	1.2%

DX 110.1 – Opening Report Ex 1, Table 1

SHAPLEY DECOMPOSITION



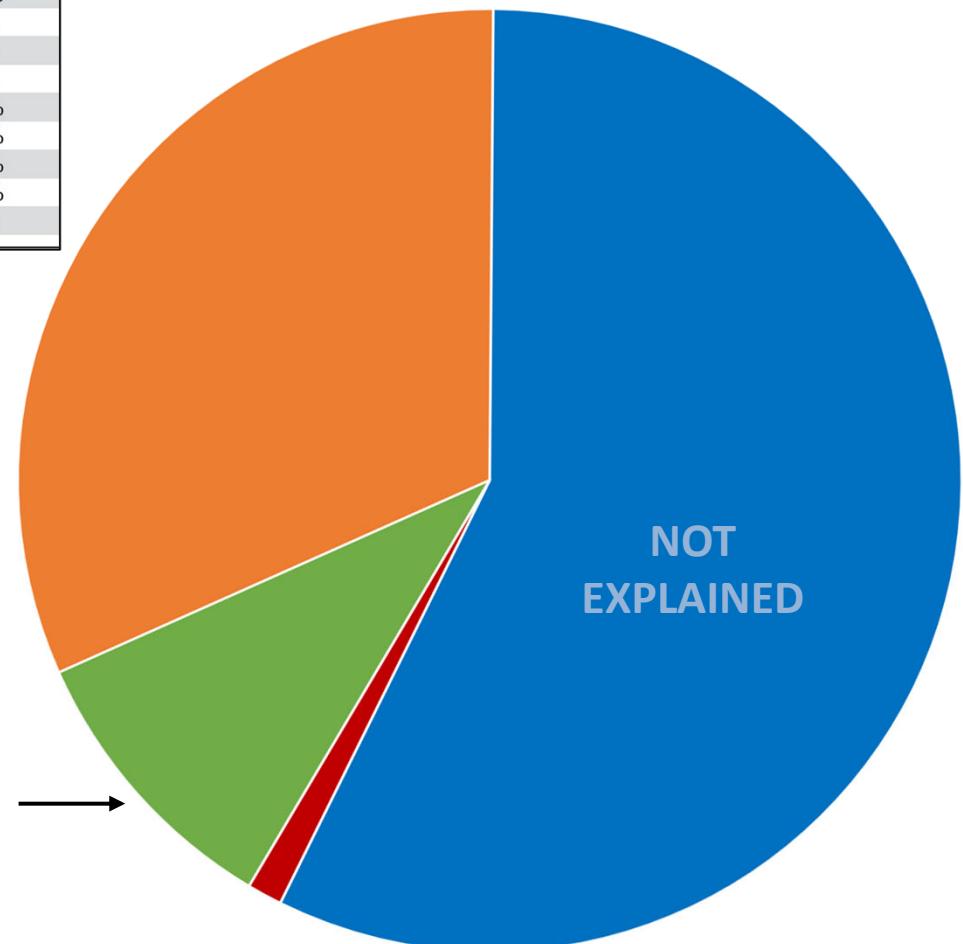
The Contribution of Test Scores to the Model

Row	Description of Specification [2]	R ²	Share of admission decision due to combined test scores
(1)	SAT Combined, ACT Comp [3] [4]	0.121	11.3%
(2)	(1) + SAT Subscores, ACT Subscores [3] [4] [5]	0.127	5.7%
(3)	(1) + Class Rank, GPA	0.254	8.4%
(4)	(3) + Sex	0.254	8.3%
(5)	(4) + NC Resident	0.364	10.6%
(6)	(5) + Min Coursework, HS Sport, Faculty / Staff Child	0.398	11.3%
(7)	(6) + Alum Parent, Early Action	0.406	11.2%
(8)	(7) + Parents' Education, Foreign Citizenship, Fee Waiver	0.409	11.0%
(9)	(8) + Within-School GPA Rank (SGR)	0.428	9.8%

DX 110.1 – Opening Report Ex 1, Table 1

SHAPLEY DECOMPOSITION

9.8%
due to including
test scores in model →



Testing Alternative Models Confirms That Race Is Not A Dominant Factor In Admissions Decisions

Separating In-State and Out-of-State

DX 112.4 – Reply Report Ex 4, Table 1

IN-STATE

Race: 1.2%

Test Scores: 14.9%

OUT-OF-STATE

Race: 5.1%

Test Scores: 18.9%

Including UNC Ratings Variables

DX 112.4 – Reply Report Ex 4, Table 1

IN-STATE

Race: 1.6%

Test Scores: 14.2%

OUT-OF-STATE

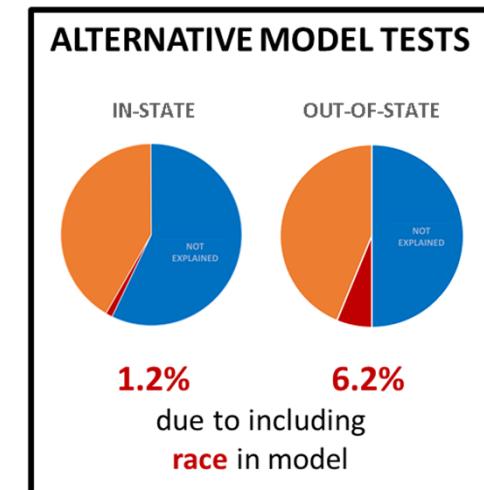
Race: 6.2%

Test Scores: 14.7%

Multiplicative Variables

DX 110.1 – Opening Report Ex 1, Table 2

Race: 5.6%

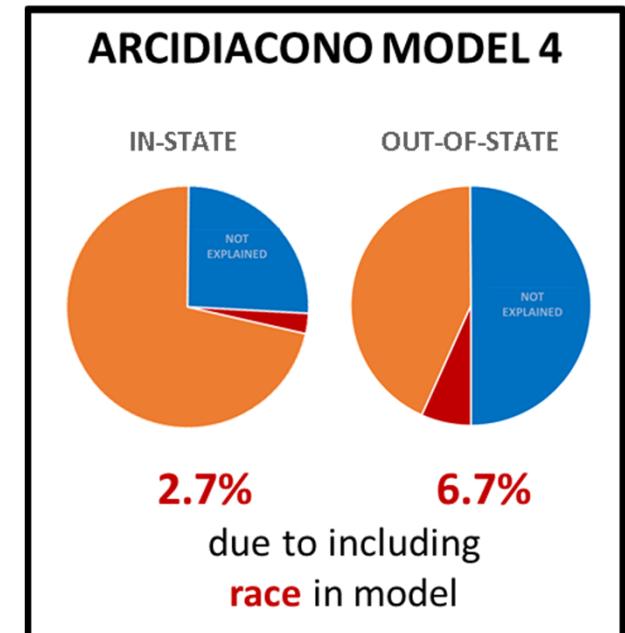


Using the Proper Econometric Method on Arcidiacono's Model Does Not Change My Conclusion

I disagree with Arcidiacono's choice to include the UNC ratings variables in his preferred model.

Regardless, he fails to employ the proper econometric method to assess these data: the Shapley Decomposition.

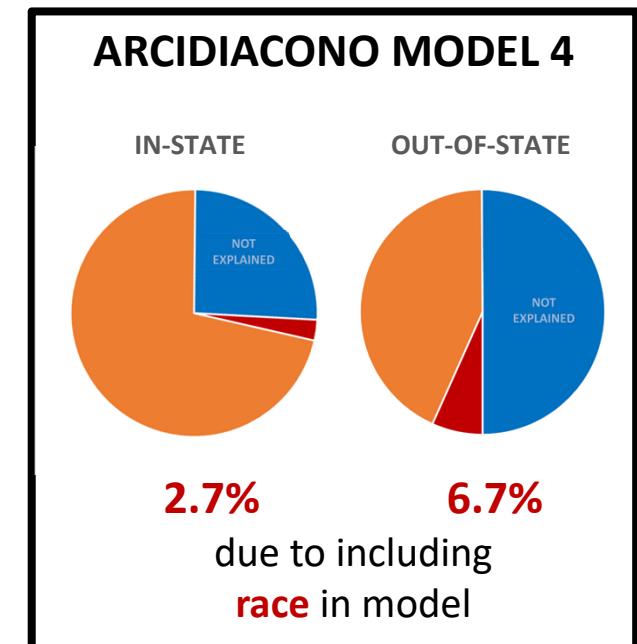
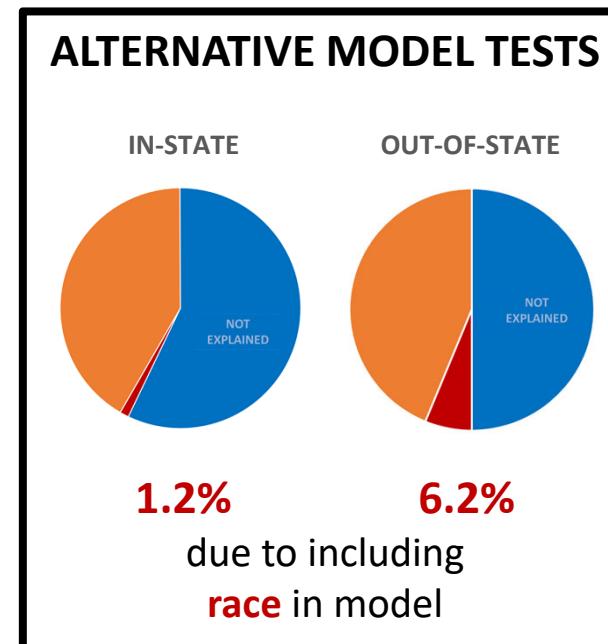
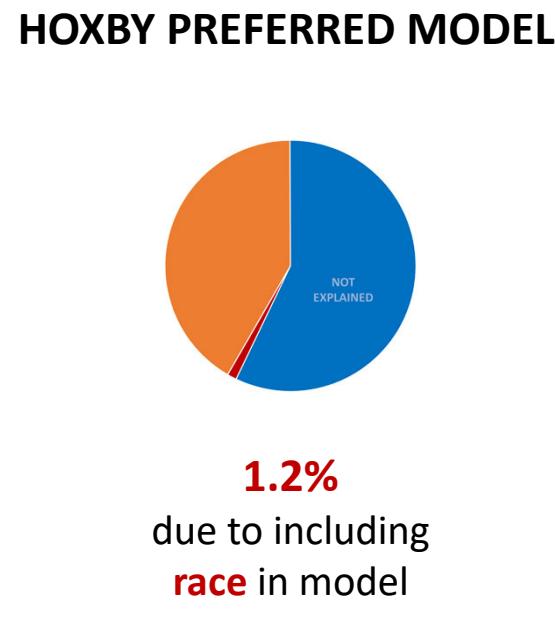
- Arcidiacono's model may have a higher R^2 , but the portion explained by race does not meaningfully increase.
- Disagreements about the model **do not change the overall result** that only a small percentage of the probability of admission is due to race.



Source: DX 111.1 – Rebuttal Report Ex 1, Table 1

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Race Is Not A Dominant Factor In Admissions Decisions



Arcidiacono's Decile Analysis is Misleading

In-State Admission Rates by Academic Index Decile and Race/Ethnicity					
Academic Decile	White	Asian American	African American	Hispanic	All Applicants
10	98.85%	98.16%	97.01%	98.44%	98.66%
9	94.07%	88.36%	97.10%	96.49%	93.42%
8	84.08%	74.40%	94.63%	87.50%	83.50%
7	69.40%	56.97%	88.49%	81.09%	69.64%
6	47.31%	44.38%	80.09%	67.69%	51.11%
5	29.56%	28.67%	71.23%	53.72%	35.61%
4	17.83%	16.91%	49.24%	38.42%	23.65%
3	7.76%	6.24%	28.77%	22.48%	13.16%
2	3.08%	1.90%	10.69%	5.21%	5.44%
1	0.70%	0.27%	1.02%	1.37%	0.89%
TOTAL	50.66%	52.87%	30.25%	40.93%	47.33%

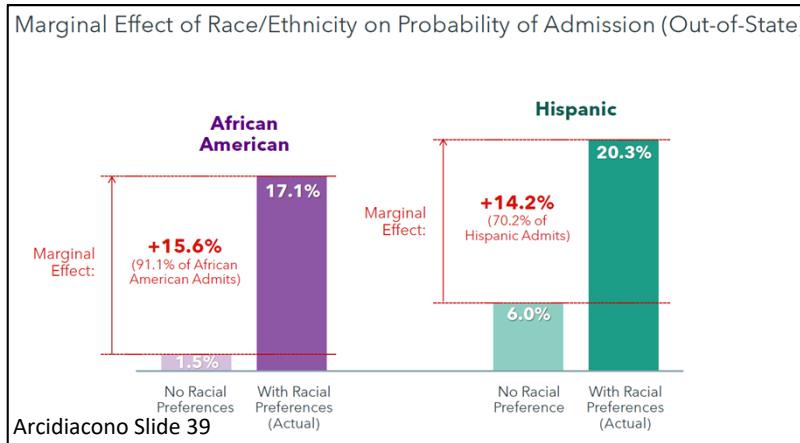
Arcidiacono Slide 12

Out-of-State Admission Rates by Academic Index Decile and Race/Ethnicity					
Academic Decile	White	Asian American	African American	Hispanic	All Applicants
10	41.58%	52.89%	73.17%	61.44%	46.97%
9	26.51%	27.66%	69.12%	42.41%	28.87%
8	15.87%	15.51%	57.87%	33.63%	18.45%
7	9.24%	6.51%	57.74%	30.35%	12.27%
6	5.34%	4.56%	46.10%	22.20%	8.43%
5	2.90%	1.38%	39.61%	15.97%	6.06%
4	1.52%	1.04%	29.85%	9.28%	4.64%
3	0.89%	0.25%	14.36%	3.61%	2.65%
2	0.52%	0.28%	5.71%	1.27%	1.54%
1	0.49%	0.00%	0.45%	0.12%	0.40%
TOTAL	10.56%	16.16%	16.67%	19.64%	12.91%

Arcidiacono Slide 15

- Arcidiacono assumes that that all deciles are equally relevant to the UNC admissions process, which they are not.
- Most UNC admitted students come from the top few deciles. Instead, Arcidiacono focuses on applicants who are “on-the-bubble.” (Deciles 4 through 6 in-state and deciles 5 through 7 out-of-state.)
- When examining whether race is a dominant factor, it is inappropriate to draw a conclusion from a small subset of admitted students.
- Arcidiacono’s decile analysis assumes away unobservable factors that contribute to the admission decisions.

Arcidiacono's "Average Marginal Effect"



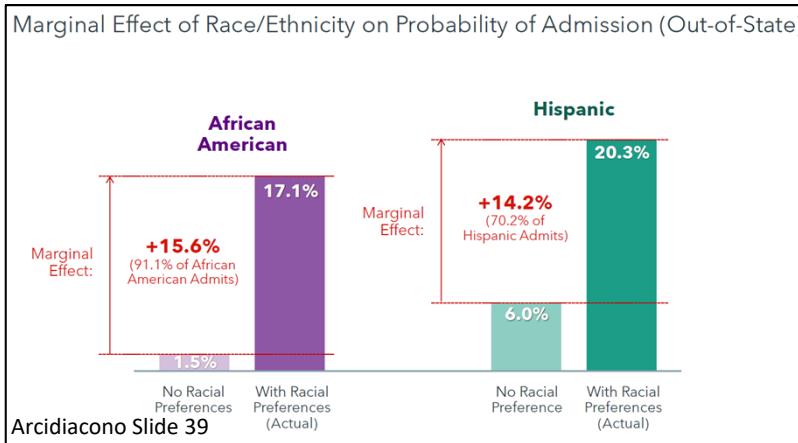
1. Marginal effect and “shares” are inapplicable in this context: we cannot assume that when we flip a switch on the factor of race, all other factors will remain constant.

Arcidiacono Measure of "Share Due to" Various Factors, Using Arcidiacono's Preferred Model [1]
 2011-12 to 2016-17 Admissions Cycles [2]

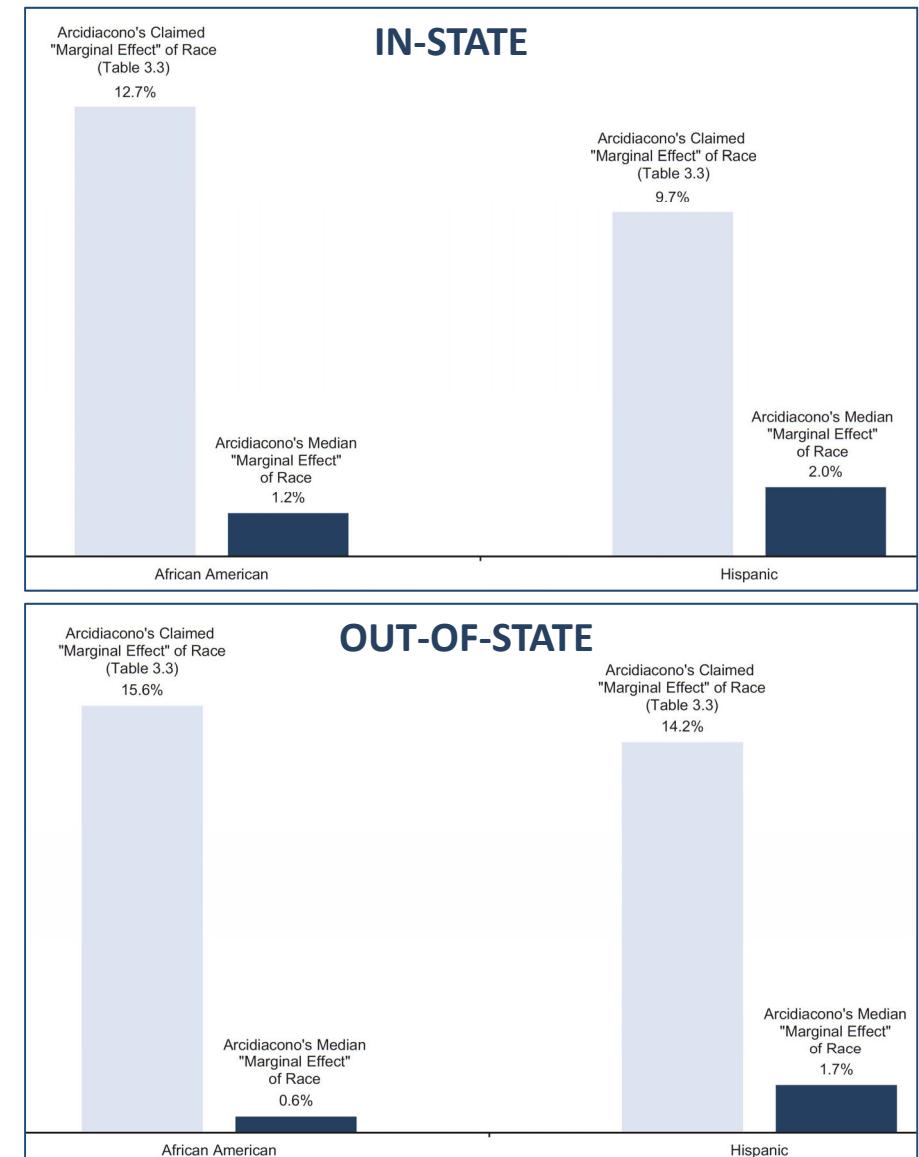
	African American Applicants	Hispanic Applicants	All Applicants
Out-of-State Applicants			
"Share Due to" SAT Preferences	100.0%	100.0%	100.0%
"Share Due to" GPA Preferences	21.1%	25.8%	29.1%
"Share Due to" Percentile Preferences	46.4%	45.6%	49.9%
"Share Due to" Program Rating Preferences	14.9%	25.6%	29.8%
"Share Due to" Essay Rating Preferences	100.0%	100.0%	100.0%
"Share Due to" Personal Quality Rating Preferences	100.0%	100.0%	100.0%
"Share Due to" Activities Rating Preferences	36.5%	42.2%	51.2%
"Share Due to" Performance Rating Preferences	33.4%	48.0%	57.4%
"Share Due to" Race/Ethnicity Preferences	91.1%	70.2%	21.5%
Total	543.4%	557.4%	538.9%

DX 112.1: Hoxby Reply Report, Exhibit 1

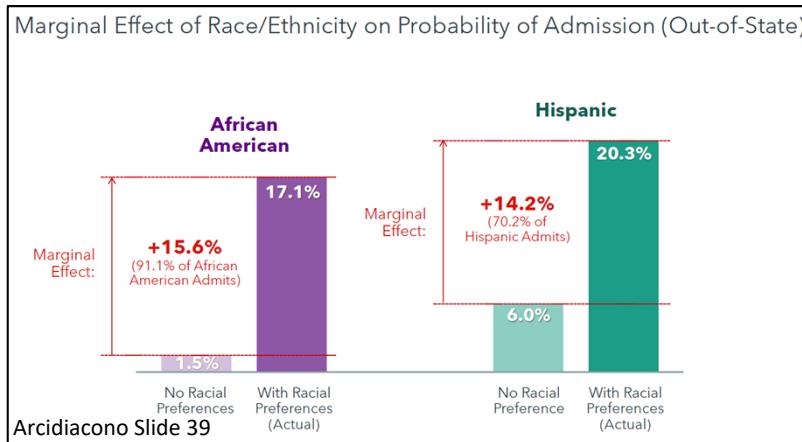
Arcidiacono's "Average Marginal Effect"



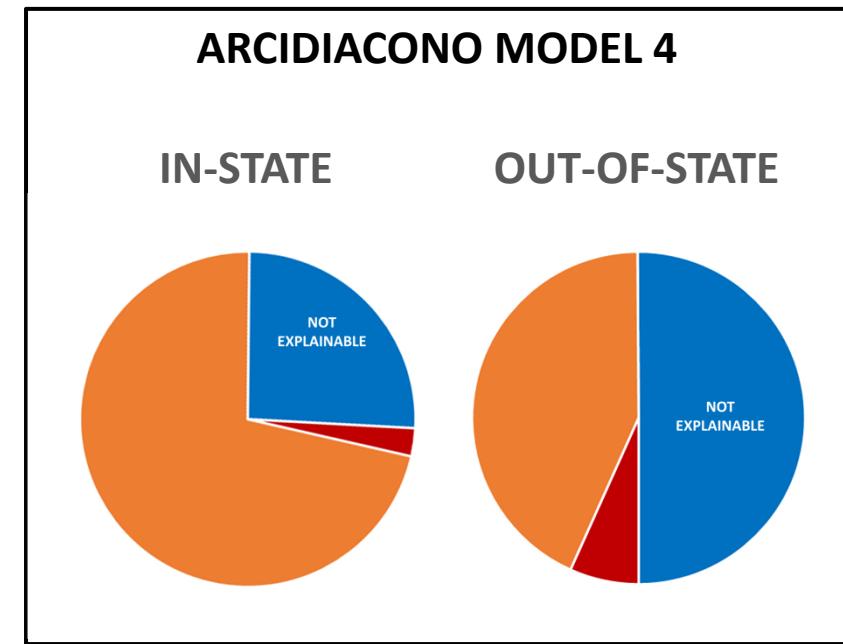
2. Even if we accept these "marginal effects," the **median** marginal effect is much smaller than the average marginal effect.



Arcidiacono's "Average Marginal Effect"



3. Arcidiacono's "marginal effects" only reflect changes in probabilities within the model itself. We cannot lose sight of the portion of admission decisions that are **not explained** by his model.



In Assessing the Accuracy of a Model, the Difference Between In-Sample And Out-of-Sample Is What Matters

Average Mean-Squared Error of Arcidiacono Models and Hoxby Model 9						
Arcidiacono In-State			In-Sample	Out-of-Sample	DIFFERENCE	Arcidiacono Out-of-State
	Model 2	0.092	0.102	0.010		
	Model 3	0.056	0.074	0.018		
	Model 4	0.055	0.074	0.019		
	Model 5	0.056	0.075	0.021		
	Model 6	0.035	0.088	0.053		
	Model 7	0.028	0.093	0.065		

Hoxby			In-Sample	Out-of-Sample	DIFFERENCE	
	Model 9	0.101	0.106	0.005		

Modified Arcidiacono Slide 55

The accuracy of a model is determined by whether it predicts as well out-of-sample as it does in-sample.

Comparing Overfit: Hoxby and Arcidiacono Models

DX 111.3: Hoxby Rebuttal Report, Exhibit 3

Average Mean-Squared Error of Arcidiacono Models and Hoxby Model 9			
Arcidiacono In-State	In-Sample	Out-of-Sample	DIFFERENCE
	Model 2	0.092	0.102
	Model 3	0.056	0.074
	Model 4	0.055	0.074
	Model 5	0.056	0.075
	Model 6	0.035	0.088
	Model 7	0.028	0.093

Arcidiacono Out-of-State	In-Sample	Out-of-Sample	DIFFERENCE
	Model 2	0.072	0.084
	Model 3	0.046	0.063
	Model 4	0.045	0.063
	Model 5	0.061	0.077
	Model 6	0.037	0.104
	Model 7	0.067	

Hoxby	In-Sample	Out-of-Sample	DIFFERENCE
	Model 9	0.101	0.106

The accuracy of a model is determined
by whether it predicts as well
out-of-sample as it does in-sample.

0.005

HOXBY
MODEL 9

0.010

ARCIDIACONO
MODEL 2
(IN-STATE)

0.018

ARCIDIACONO
MODEL 4
(OUT-OF-STATE)ARCIDIACONO
MODEL 6
(OUT-OF-STATE)

Arcidiacono's Concept of "Accuracy" Only Reinforces the Finding That Race Is Not A Dominant Factor

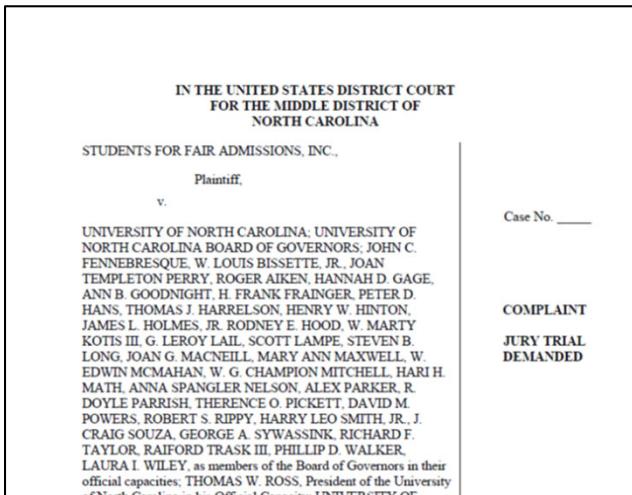
Even under Arcidiacono's definition of "accuracy", removing alleged racial preferences does not significantly change the "accuracy" of Arcidiacono's models.

This shows that his models do not support his conclusion that race is a dominant factor in UNC's admission decisions.

	<u>Overall "Accuracy"</u>
In-State Applicants	
Arcidiacono's Preferred Model with "Racial Preferences" [2]	92.1%
Arcidiacono's Preferred Model without "Racial Preferences" [3]	91.1%
Difference in "Accuracy" (with "Racial Preferences" – without "Racial Preferences")	1.0%
Out-of-State Applicants	
Arcidiacono's Preferred Model with "Racial Preferences" [4]	93.3%
Arcidiacono's Preferred Model without "Racial Preferences" [3]	91.4%
Difference in "Accuracy" (with "Racial Preferences" – without "Racial Preferences")	1.9%

DX 112.3: Hoxby Reply Report, Exhibit3

Other Allegations in SFFA's Complaint



49. The Admissions Director is aware of the projected racial composition of the tentatively admitted students during the SGR process. The reports used during the SGR process include information regarding each candidate's race/ethnicity. Those reports, however, do not include information regarding non-race factors such as first generation college status or eligibility for a fee waiver.

Analysis of School Group Review Data

	2013-14		2014-15		2015-16	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
African American	10.1%   NO CHANGE		9.3%   0.3%		10.1%   0.1%	
Asian	19.2%   0.2%		20.5%   0.2%		20.4%   0.5%	
Hispanic	9.3%   1.0%		8.5%   NO CHANGE		9.4%   0.2%	
Native American	1.7%   NO CHANGE		1.6%   NO CHANGE		1.5%   NO CHANGE	
Pacific Islander	0.1%   NO CHANGE		0.1%   NO CHANGE		0.0%   0.1%	
White	59.7%   0.8%		60.0%   0.1%		58.5%   NO CHANGE	

DX 110.2 – Opening Report Ex 2, Table 1

Opinions Reached

1

Empirical analysis establishes that UNC's admissions decisions are holistic and cannot be explained using a formula containing verifiable student characteristics.

Race / ethnicity is not a dominant factor in the admissions process at UNC.

2

Exhaustive simulations resulted in no race-neutral admissions policy that would allow UNC to attain the levels of academic preparedness and underrepresented minority representation of its actual entering class, even when those simulations are built on generous assumptions to maximize their chances of attaining the actual levels.

Testing Race-Neutral Alternatives

1. Build admissions model using race-blind proxy



WHO WOULD
APPLY?

WHO WOULD
BE ADMITTED?

WHO WOULD
ENROLL?

2. Compare **results of simulation** against **UNC actual levels** of academic preparedness and underrepresented minority representation



vs.



Applied Assumptions to Give the Simulations the Best Possible Chance to Attain UNC's Actual Racial Diversity & Test Scores

The applicant pool

ASSUMPTION

Assume that all actual applicants continue to apply

ACT / SAT scores

ASSUMPTION

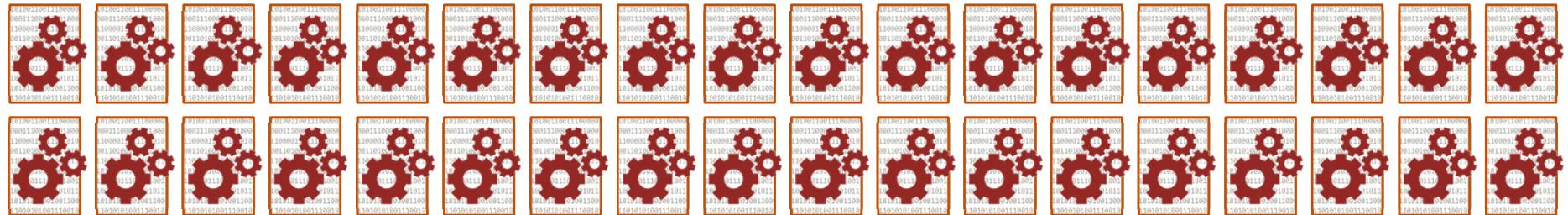
Assume applicants would take ACT or SAT more than once
(+40 SAT for students taking only once)

Those who would enroll

ASSUMPTION

Assume that current enrollment probabilities hold

Exhaustive Approach: 109 Different Simulations



Socioeconomic Plans: 82



Top X Percent Plans: 5

Additional Concepts Suggested by Kahlenberg: 20



Geography Based Plans: 2

Simulations Matching UNC'S Actual Average SAT and % URM

: 0

Socioeconomic Status Indicators: Potential Proxies

- Eligibility for free or reduced price lunch
- Household income
- % of adults with educational attainment ranging from none to doctoral degree
- Mean educational attainment of adults
- % of families headed by single parent
- Mean number of dependents
- Rural/urban/central city/population size indicators
- % of students in high school on free or reduced price lunch

DX 110: Opening Report, paragraph 150

Socioeconomic Status Is Not An Effective Proxy for Race

THE MORE ACADEMICALLY PREPARED A STUDENT IS,
THE LESS THE SOCIOECONOMIC VARIABLES
ARE ABLE TO PREDICT WHETHER THE STUDENT IS URM:

- All levels of preparation*..... **83%** error rate
- SAT > 1000..... **89%** error rate
- SAT > 1100..... **91%** error rate
- SAT > 1120..... **91%** error rate
- SAT > 1220..... **92%** error rate
- SAT > 1260..... **94%** error rate

error rate =
student is not URM
when socioeconomic
variables predicts
they are.

Socioeconomic Status-Based Simulations

1. Construct an SES index measure for every applicant.
2. Define ranges of emphasis* and threshold** to give to the SES index.
3. SES “Disadvantage Preference” :
Predict students admitted as a result of SES status using favorable assumptions about the new applicant pool.
4. Complete the Class:
Predict the admissions outcomes for remaining applicants.

* **Emphasis** is the weight the SES index is given in admissions.

** **Threshold** is the cut-off at which a student is held to be socioeconomically disadvantaged—e.g. “how low in income?”

SES Simulations Structured as Favorably as Possible

Assumed UNC could:

1. Identify all of the socioeconomically “disadvantaged” students and get them to apply at the same rate as current, well-qualified applicants
2. Choose to admit the highest scoring students
3. Continue to enroll current admitted applicants

When “completing the class,” take UNC’s actual applicants as given.

- This assumes highly qualified students would continue to apply even though their chance of admission might decrease substantially under a new admissions process that emphasizes socioeconomic status.

Categories of SES-Based Simulations

LIKELIHOOD OF ATTENDING 4 or 2 YEAR COLLEGE INDEX

A student's predicted probability of attending either a four or two-year college based on socioeconomic background.

STRIVER INDEX

The difference between actual and predicted test score of a student. The index is positive if the student outperforms expectations, given socioeconomic background.

RACE PREDICTING INDEX

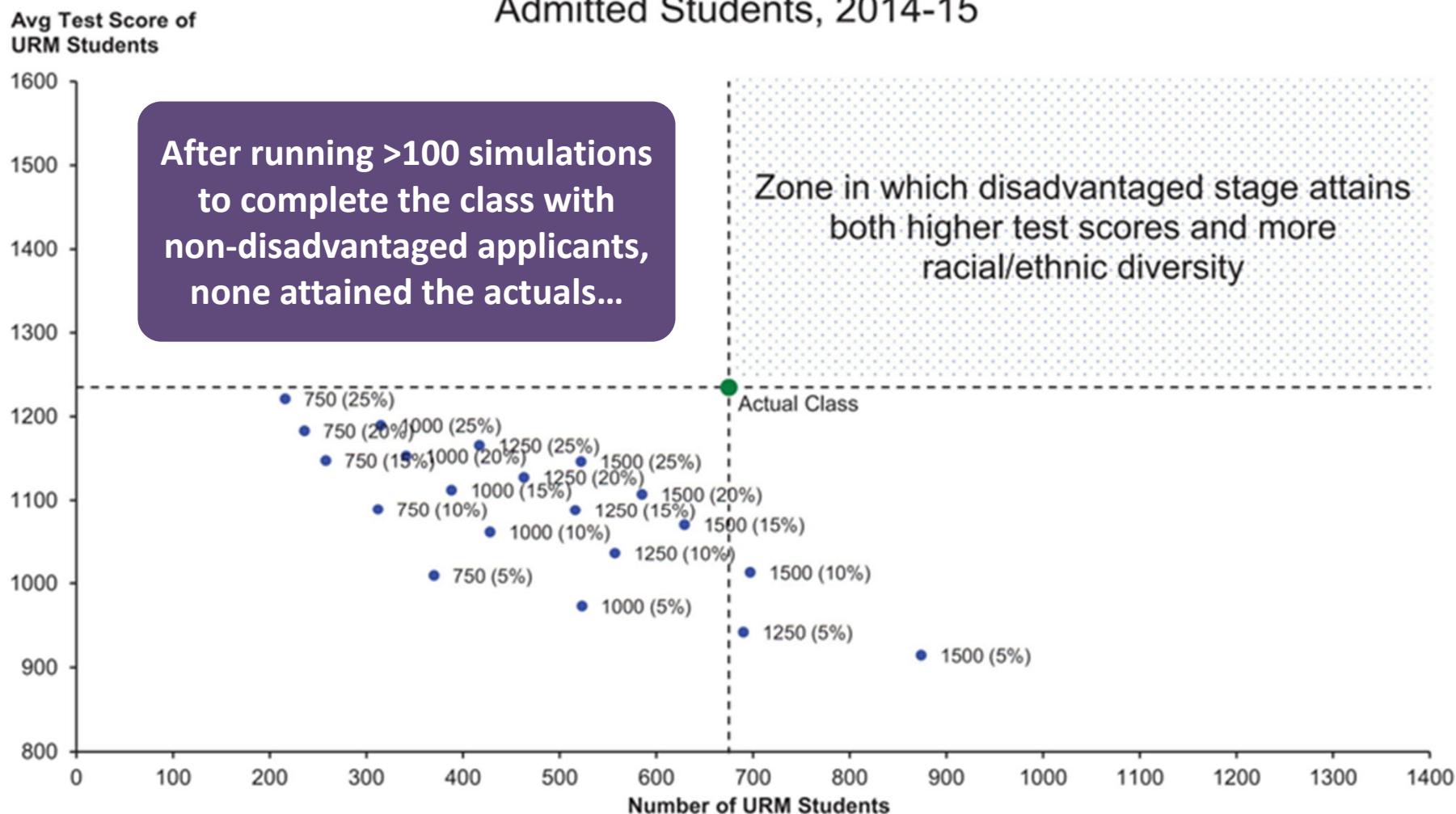
Artificial index constructed to maximize the probability that socioeconomic variables correctly predict underrepresented minority status.

* This index is meant to test the *ceiling* of what can be attained by SES in an RNA. It does not have any race-neutral logic.

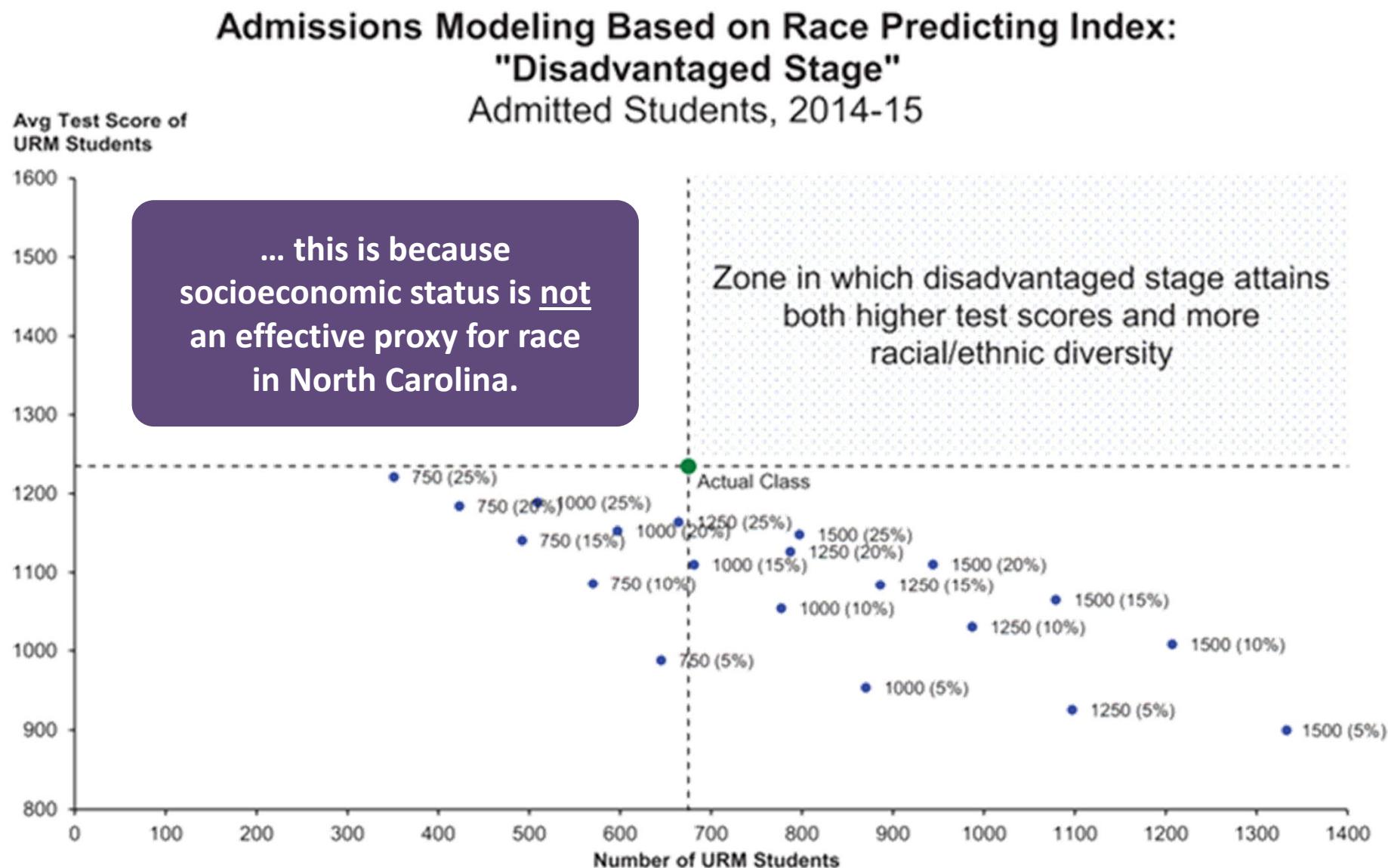
No Simulated Pool of Admitted Students Attained Current Levels of Academic Preparation & Racial Diversity

Admissions Modeling Based on Four-Year College-Related Socioeconomic Index: "Disadvantaged Stage"

Admitted Students, 2014-15

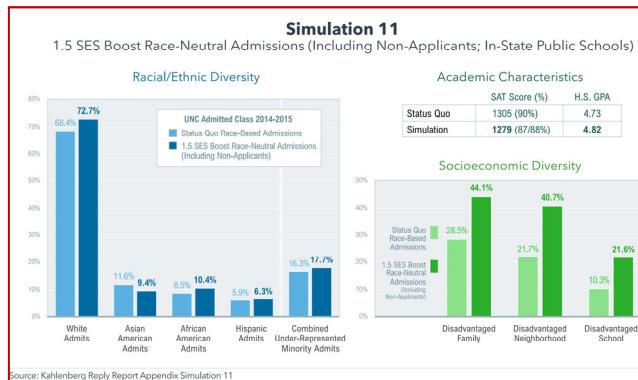
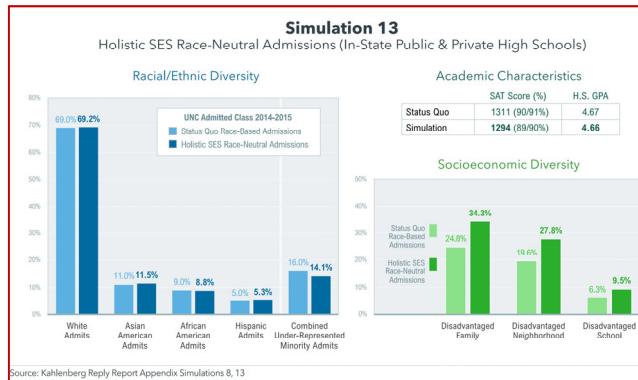
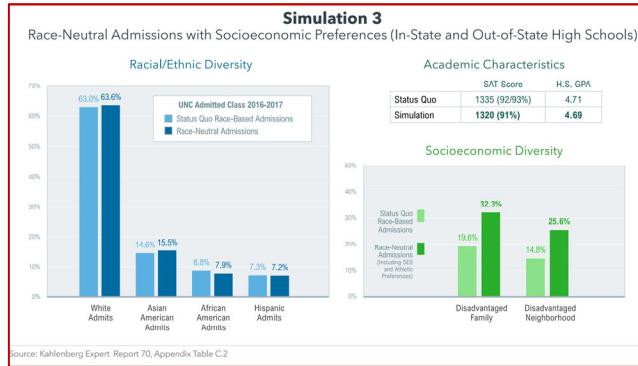


No Simulated Pool of Admitted Students Achieved Current Levels of Academic Preparation & Racial Diversity



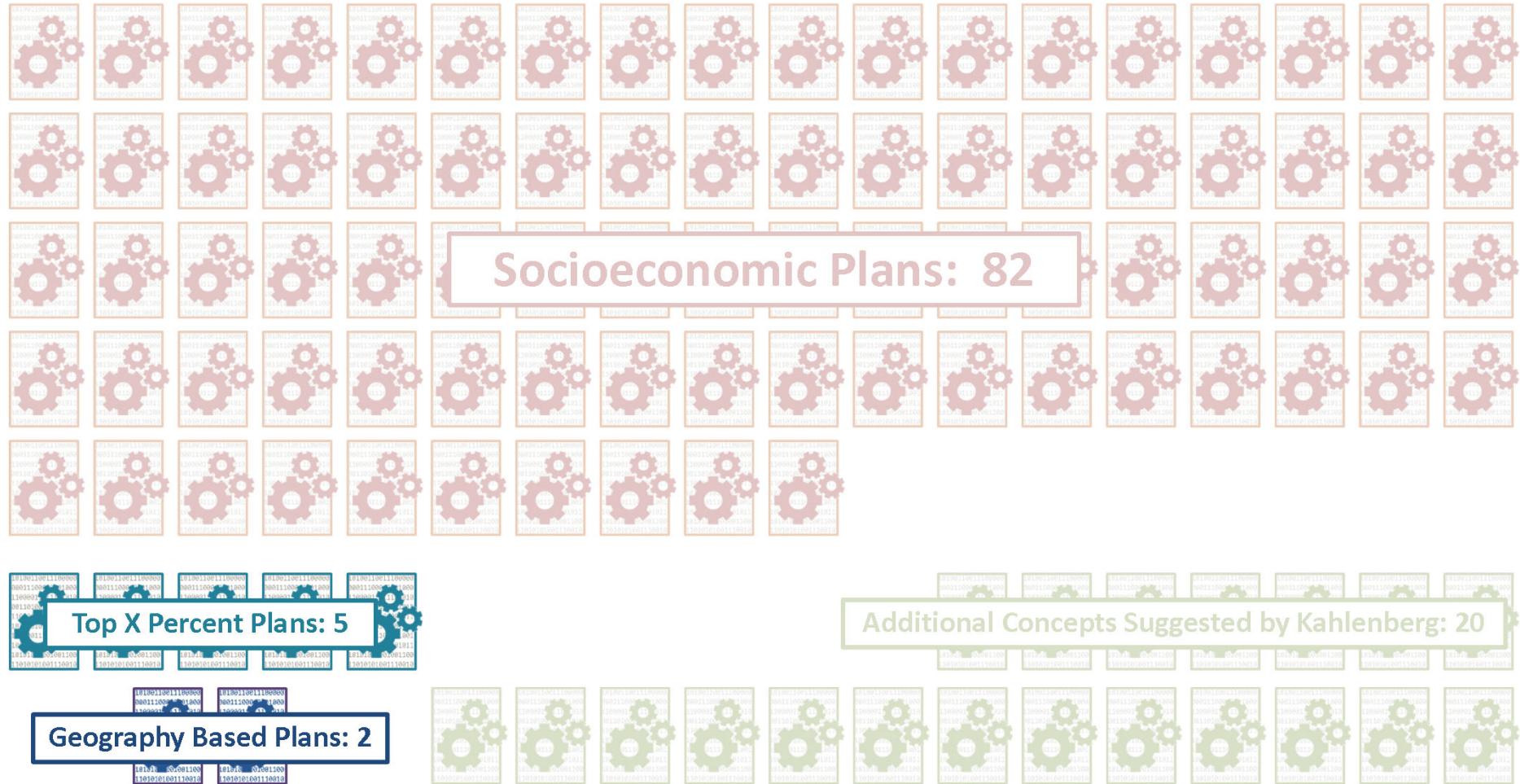
DX 110.9: Opening Report Exhibit 9 Figure 7

Kahlenberg's Approach To SES-Based Simulations Is Fundamentally Flawed

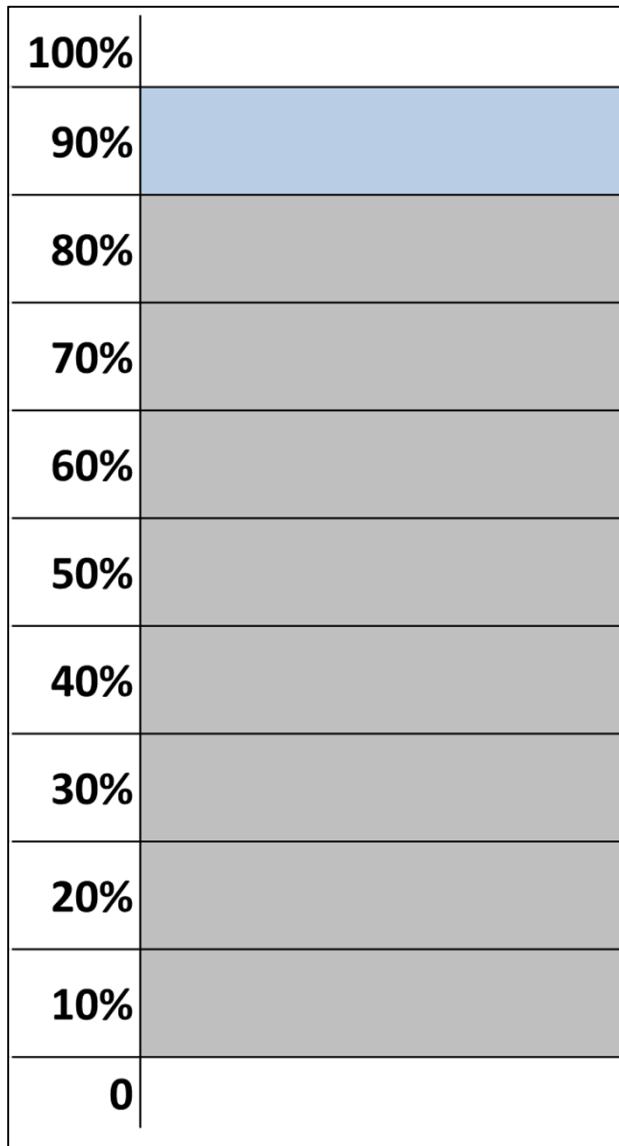


- Kahlenberg makes unrealistic assumptions.
- His simulations frequently fail to reflect that the applicant pool will change.
- His simulations rely on extremely large “boosts” based on the SES index.
- Kahlenberg places heavy emphasis on socioeconomic diversity to evaluate simulation results rather than focusing on racial / ethnic diversity.

Exhaustive Approach: 109 Different Simulations



Percentage Plans



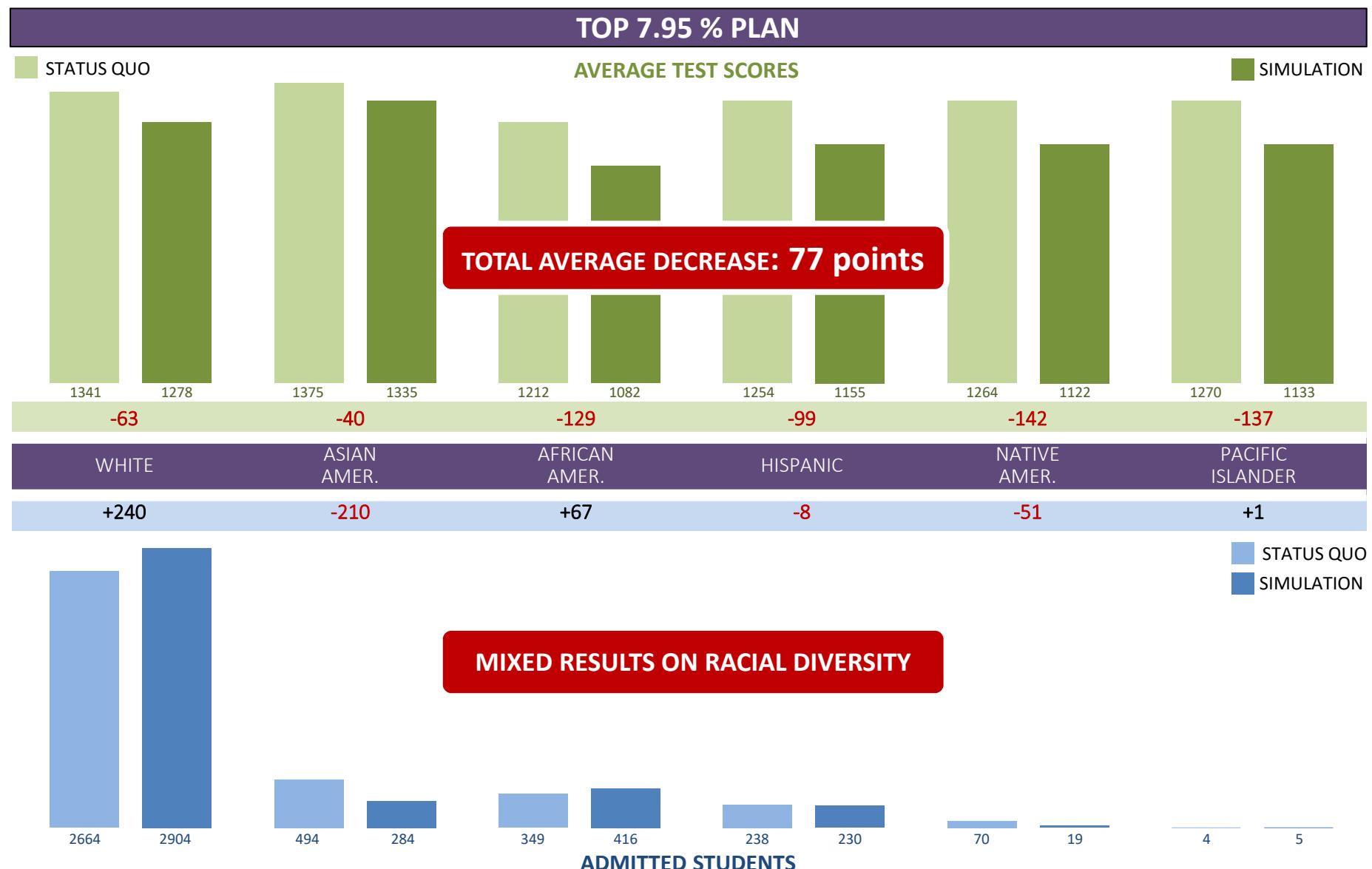
A top X percent plan typically admits X% of students based upon **high school class rank**.

X depends on:

- The number of seats available at UNC.
- What percentage of students who are eligible for admission enroll at UNC.

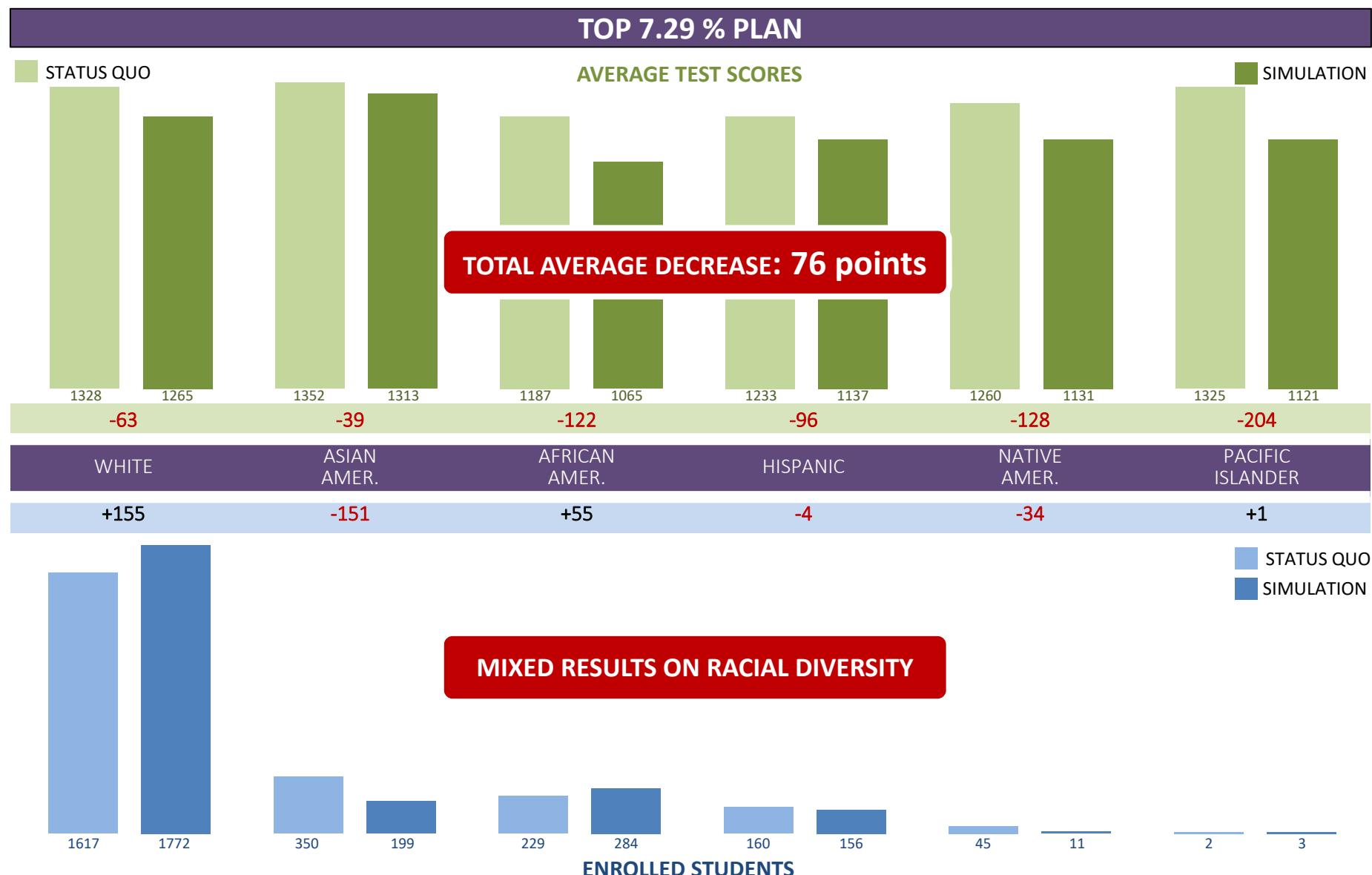
Percentage Plan Simulations: Admitted Students

Significant Decreases in Test Scores



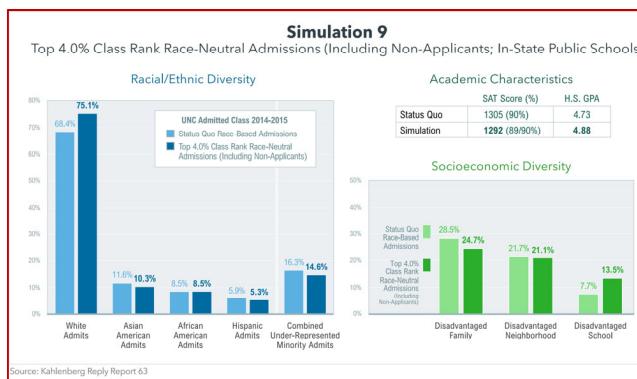
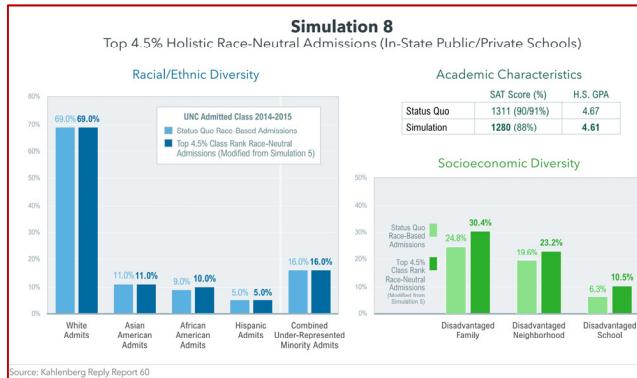
Source: DX 110.11: Hoxby Report Exhibit 11 Table 1

Percentage Plan Simulations: Enrolled Students Significant Decreases in Test Scores



Source: DX 110.11: Hoxby Report Exhibit 11 Table 2

Kahlenberg's Flawed "Percentage" Plans



- Kahlenberg's Top X% Simulations fail to reflect that the applicant pool will change if UNC's admissions policy changes.
- Kahlenberg fails to properly account for capacity constraints: how many students UNC can admit and enroll.
- Kahlenberg overweights test score and GPA when completing the class.

Geography-Based Plans

Place-based proxy instead of using high school class rank

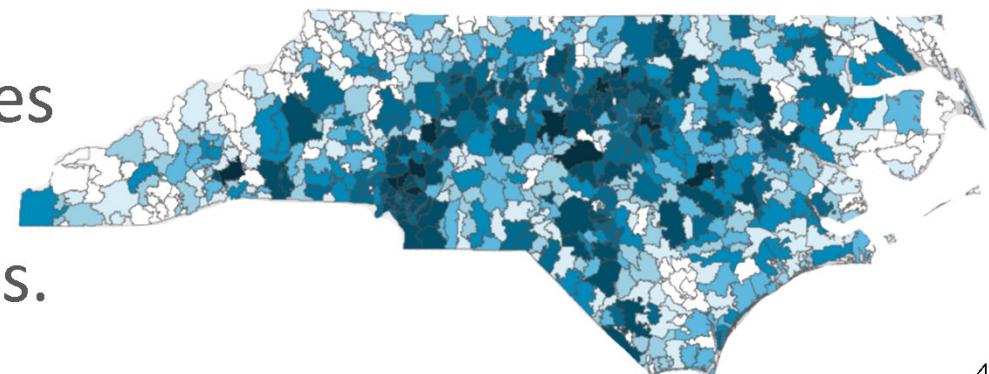
Premise: *a small geographic zone's historical admission rate is highly predictive of a current applicant's advantage or disadvantage related to attending selective colleges.*

Modeled two types of theoretical simulations:

1. Census Tract Plan
2. Race Predicting Index Based on Geography

**Structured RNA as
favorably as possible:**

- More weight to test scores and GPA than UNC's actual admissions process.



Geographical Plan Simulation 1

1. Compute the historical admissions rate among reasonably well-qualified students in each Tract.
2. The Tract Index gives a *higher* priority to tracts with *lower* historical admission rates.
3. Taking tracts in priority order, apply a hypothetical admissions process that admits each tract's top students (equal weighting of test score and GPA) until class is filled.
4. Consider results in the context of a hypothetical status quo resulting from an admissions process where applicant pool is admitted solely on the basis of test scores and GPA.

**FINDING:
SIGNIFICANT DECREASE
IN RACIAL DIVERSITY**

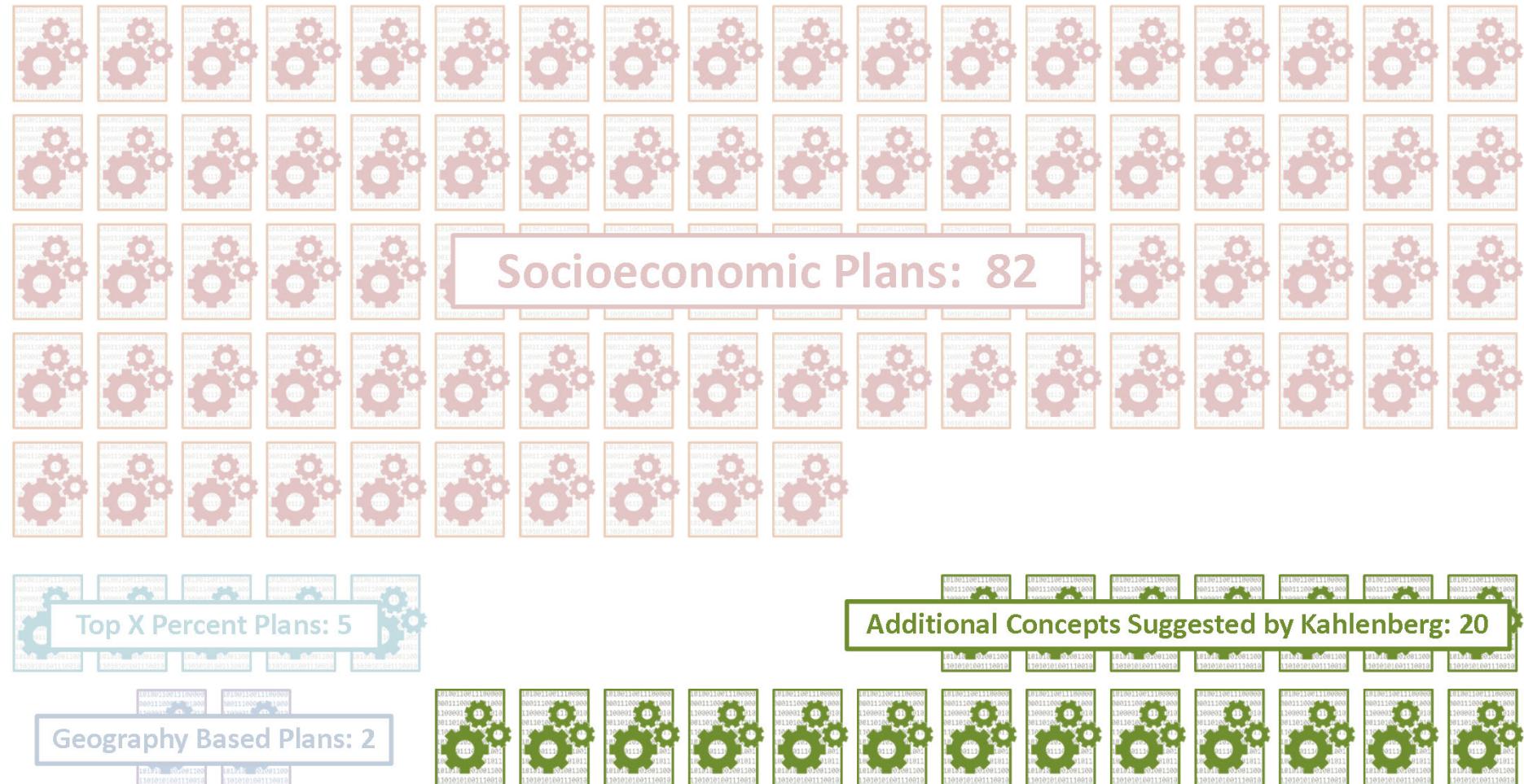
Geographic Plan Simulation 2: Race Predicting Index that includes Geography

Artificial index using geography and socioeconomic status variables from broader applicant pool to try to predict URM status. As with the earlier race-predicting index, this is meant to test the ceiling of what can be attained with a race-blind index. There is no race-neutral logic behind this artificial index.

- Predict admissions outcomes based on model of UNC admissions using RPI Index instead of actual race/ethnicity.
- Compare against hypothetical status quo of current applicant pool if UNC admitted students based on admissions model.

**FINDING:
SIGNIFICANT DECREASE
IN RACIAL DIVERSITY**

Exhaustive Approach: 109 Different Simulations



Additional “Alternatives” Suggested by Kahlenberg

Partnerships with disadvantaged high schools

1. Focused on disadvantaged high schools previously incorporated into SES simulations
2. Tested 16 different simulations:
All resulted in substantially lower average test scores

Community college transfers

1. Considered potential transfers from North Carolina State University: **Resulted in lower average test scores and less racial diversity**
2. Used NCERDC data to consider students who indicated they were likely to attend community college:
Resulted in substantially lower average test scores

Kahlenberg Misinterprets My Prior Research

- My research focuses upon highly academically qualified, low income students who do not apply to selective universities (“one-offs”).
- Four years of NCERDC data reveals the vast majority of one-offs (86%) are not URMs.
- Such recruiting is not a substitute for race-conscious admissions.

Opinions Reached

1

Empirical analysis establishes that UNC's admissions decisions are holistic and cannot be explained using a formula containing verifiable student characteristics.

Race / ethnicity is not a dominant factor in the admissions process at UNC.

2

Exhaustive simulations resulted in no race-neutral admissions policy that would allow UNC to attain the levels of academic preparedness and underrepresented minority representation of its actual entering class, even when those simulations are built on generous assumptions to maximize their chances of attaining the actual levels.